

Experimental Demonstration of the Molten Oxide Electrolysis Method for Oxygen and Iron Production from Simulated Lunar Materials

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Extended Abstract:

This paper presents the results of a Marshall Space Flight Center funded effort to conduct an experimental demonstration of the processing of simulated lunar resources by the molten oxide electrolysis (MOE) process to produce oxygen and metal from lunar resources to support human exploration of space.

Oxygen extracted from lunar materials can be used for life support and propellant, and silicon and metallic elements produced can be used for in situ fabrication of thin-film solar cells for power production. The Moon is rich in mineral resources, but it is almost devoid of chemical reducing agents, therefore, molten oxide electrolysis, MOE, is chosen for extraction, since the electron is the most practical reducing agent.

MOE was also chosen for following reasons. First, electrolytic processing offers uncommon versatility in its insensitivity to feedstock composition. Secondly, oxide melts boast the twin key attributes of highest solubilizing capacity for regolith and lowest volatility of any candidate electrolytes. The former is critical in ensuring high productivity since cell current is limited by reactant solubility, while the latter simplifies cell design by obviating the need for a gas-tight reactor to contain evaporation losses as would be the case with a gas or liquid phase fluoride reagent operating at such high temperatures.

In the experiments reported here, melts containing iron oxide were electrolyzed in a low temperature supporting oxide electrolyte (developed by D. Sadoway, MIT). The production of oxygen and reduced iron were observed (Fig. 1).

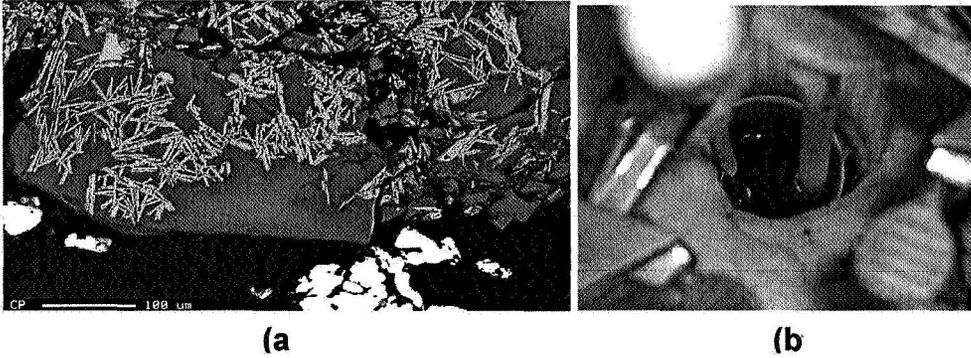


Figure 1. (a) High purity Fe crystals obtained at cathode by reduction of Fe_2O_3 and (b) bubbling of O_2 gas at anode (right electrode)

Electrolysis was also performed on the supporting electrolyte with JSC-1 Lunar Simulant. Figure 2 shows the cyclic voltammetry curves for the supporting electrolyte with and without JSC-1 Lunar.

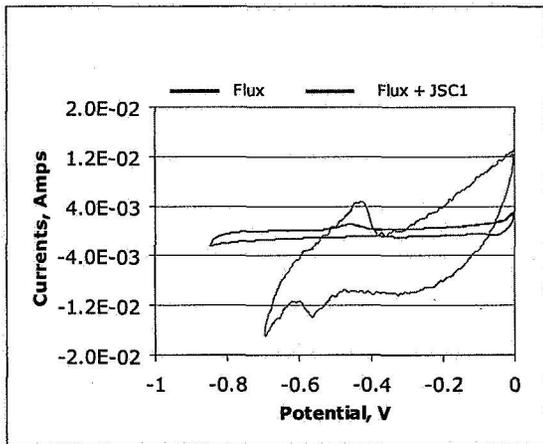


Figure 2. Cyclic Voltammetry of Supporting Electrolyte (flux) with and without JSC-1 Lunar Simulant

The cell current for the supporting electrolyte alone is negligible while the current for the electrolyte with JSC-1 shows significant current and a peak at about -0.6 V indicating reductive reaction in the simulant.